

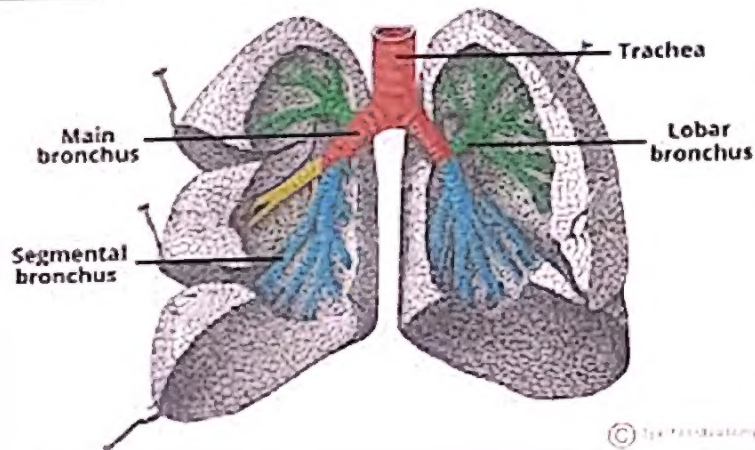


**LOBACHEVSKY  
UNIVERSITY**

## **Sputum**

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# Tracheobronchial secret

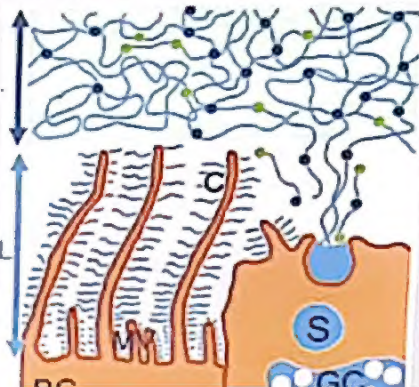


**Tracheobronchial secret consists of mucus produced by the glands of the trachea and large bronchi. It may contain cellular elements: lymphocytes and macrophages.**

**Normally, no more than 10-100 ml per day is released.**

**The tracheobronchial secret has two layers: internal liquid (sol) located on the ciliated epithelium in the form of a film; the outer insoluble gel is denser and more viscous.**

**The sol contains biologically active substances, enzymes, immunoglobulins, it performs a protective function, the gel is formed by mixing the sol and goblet cell secretion - this is a network of glycoproteins linked by disulfide bridges.**





## **Functions of the tracheobronchial secretion**

**The tracheobronchial secret helps to remove foreign particles caught during breathing, including microorganisms.**

**Provides specific (Ig) and non-specific (bactericidal properties) immunological protection**


**The tracheobronchial secret contains proteolytic enzymes and their inhibitors. This provides antimicrobial protection (proteolysis of microorganisms and proteins) and neutralization of the damaging effect of microbial proteases and their own proteolytic enzymes to prevent autolysis of their own proteins.**

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**Sputum is a pathological secretion formed in the respiratory system as a result of a disease or damage to the respiratory organs and thrown out with a cough from the respiratory tract: lungs, bronchi, trachea, larynx.**

**Sputum is the secret of the lungs and respiratory tract (bronchi, trachea, larynx), which is separated by coughing. Healthy people do not produce sputum.**



- 
- **The appearance of sputum is a symptom of a disease of the lungs or bronchi. The nature of sputum is due to the pathological process, and the microscopic structures found in it indicate a specific disease**
  - **Sputum examination allows you to establish:**
    - **- The nature of the pathological process**
    - **- The etiology of the disease**

### **Stages of clinical examination of sputum:**

- 1. Macroscopic examination: inspection, evaluation of physical and chemical properties**
- 2. Microscopy: native preparation, stained preparation**
- 3. Bacteriological examination**
- 4. Cytological examination**

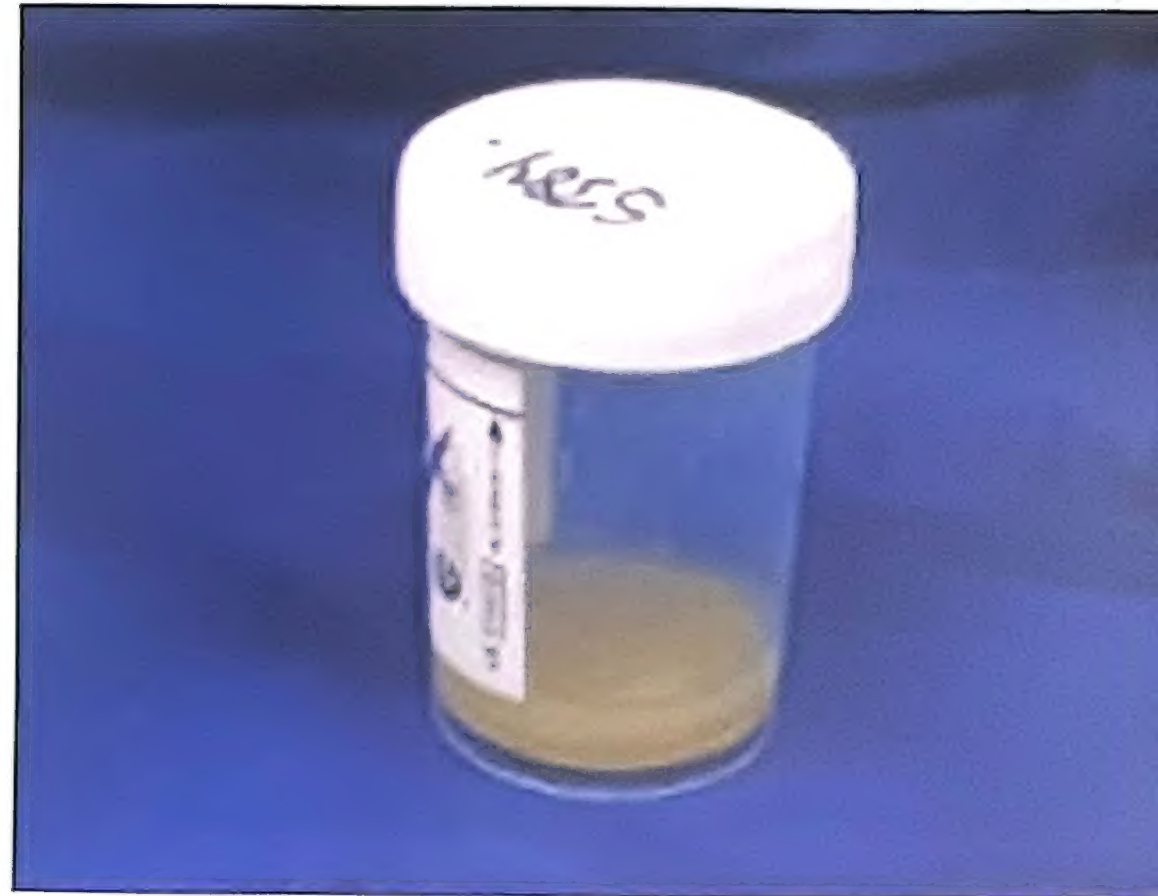
# Rules for collecting sputum

- ☐ Sputum is collected after rinsing the mouth with water in a dry glass, plastic container with a screw cap or a Petri dish in the morning when the bronchi are maximally filled with sputum. (before meals).
- ☐ If necessary, sputum is stored in a cool place (in the refrigerator) for no more than 2-3 hours.
- ☐ With longer storage of sputum, fermentation and decay processes develop in the biomaterial, distorting the results of the study.



## Macroscopic examination:

- *The amount of sputum*
- *Color*
- *Smell*
- *Consistency*
- *Presence of inclusions*



## The amount of sputum

**The daily amount of sputum varies widely - from 1 to 1000 ml or more.**

**A small amount of sputum is released with inflammation of the respiratory tract:**

**laryngitis,**

**tracheitis,**

**acute bronchitis;**

**bronchial asthma without an attack;**

**bronchopneumonia.**

**In chronic bronchitis, pulmonary tuberculosis, sputum is allocated 25-100 ml.**

**A large amount of sputum (from 0.5 to 2 liters) is excreted when:**

- ✓ bronchiectasis;**
- ✓ lung abscess;**
- ✓ some helminthic diseases.**
- ✓ With the breakthrough of empyema, the amount of sputum can reach up to 4 liters.**



## **Sputum color**

**The color of sputum depends on the number of leukocytes and the admixture of erythrocytes.**

**The admixture of erythrocytes gives red, brownish or rusty color of sputum.**

**The sputum may only stain with blood in places or have a slightly reddish tint.**

**Sputum with blood is observed more often in pulmonary tuberculosis, but it can be actinomycosis, gangrene, neoplasms, syphilis, lung injuries. Blood may not be of pulmonary origin: from the nasal cavity, stomach, with a breakthrough of an aortic aneurysm into the lumen of the bronchus or trachea.**

## Sputum color

- ✓ **Raspberry-colored sputum is observed in malignant neoplasms of the lung.**
- ✓ **Yellow sputum is observed with general jaundice.**
- ✓ **The black color of sputum is caused by a significant admixture of coal dust.**
- ✓ **Brown sputum is released during abscess, bronchiectasis of the lung, breakthrough of pleural empyema due to decomposition of hemosiderin by bacterial enzymes.**
- ✓ **The rusty color of sputum is more common with croupous pneumonia due to the appearance of hematin, which is released during the breakdown of red blood cells.**
- ✓ **The color of sputum may be due to impurities of wine, coffee, medicines, etc.**

## **Sputum consistency**

**Sputum can be: liquid, viscous, gelatinous, moderately viscous, viscous. The viscosity of sputum largely depends on the content of microorganisms in it, the proteolytic enzymes of which contribute to the decomposition of sputum.**

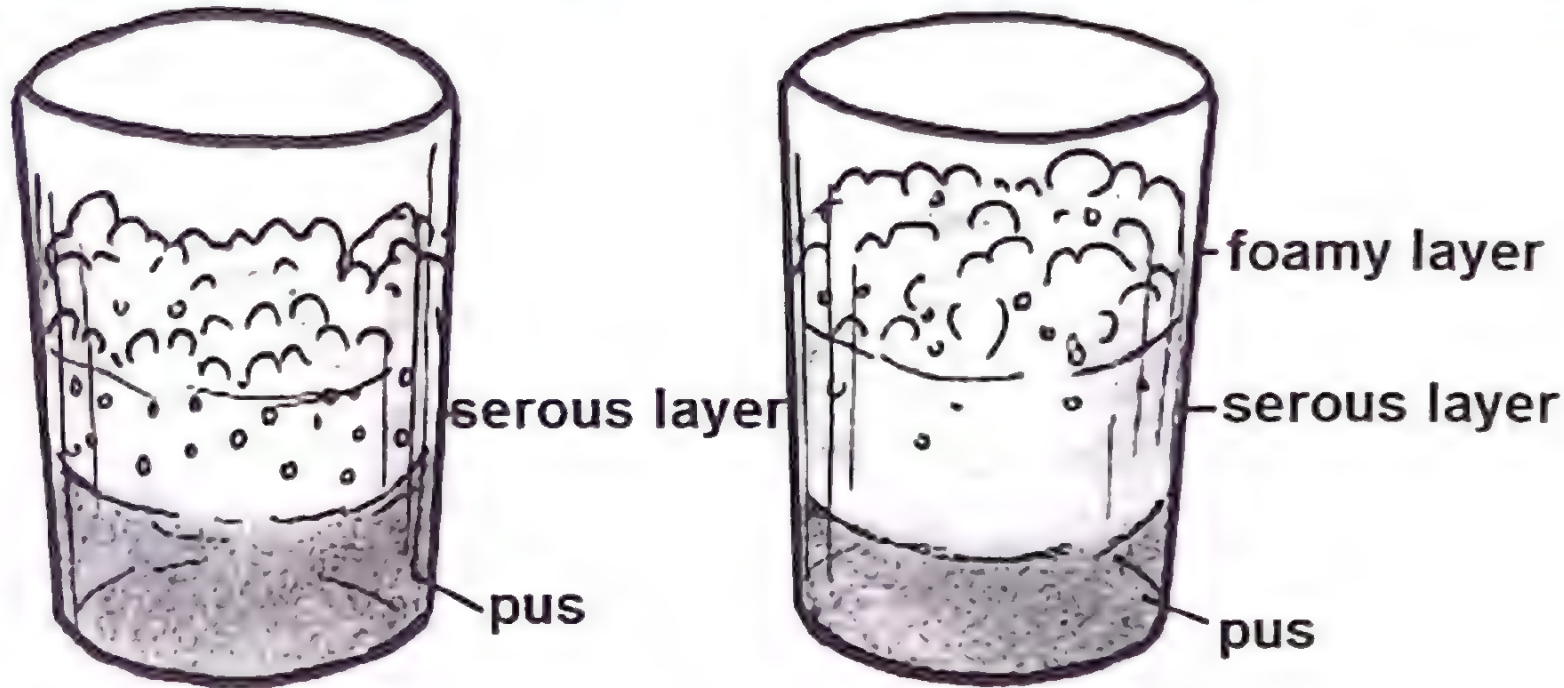
**With an increase in the inflammatory process in the bronchi, the amount of protein, leukocytes and pathogenic microorganisms increases, sputum liquefaction is noted.**

**Antibacterial therapy contributes to the thickening of sputum.**



## Dividing sputum into layers

In diseases with a large separation of liquid sputum in a glass vessel, it usually exfoliates.



**Two-layer sputum**

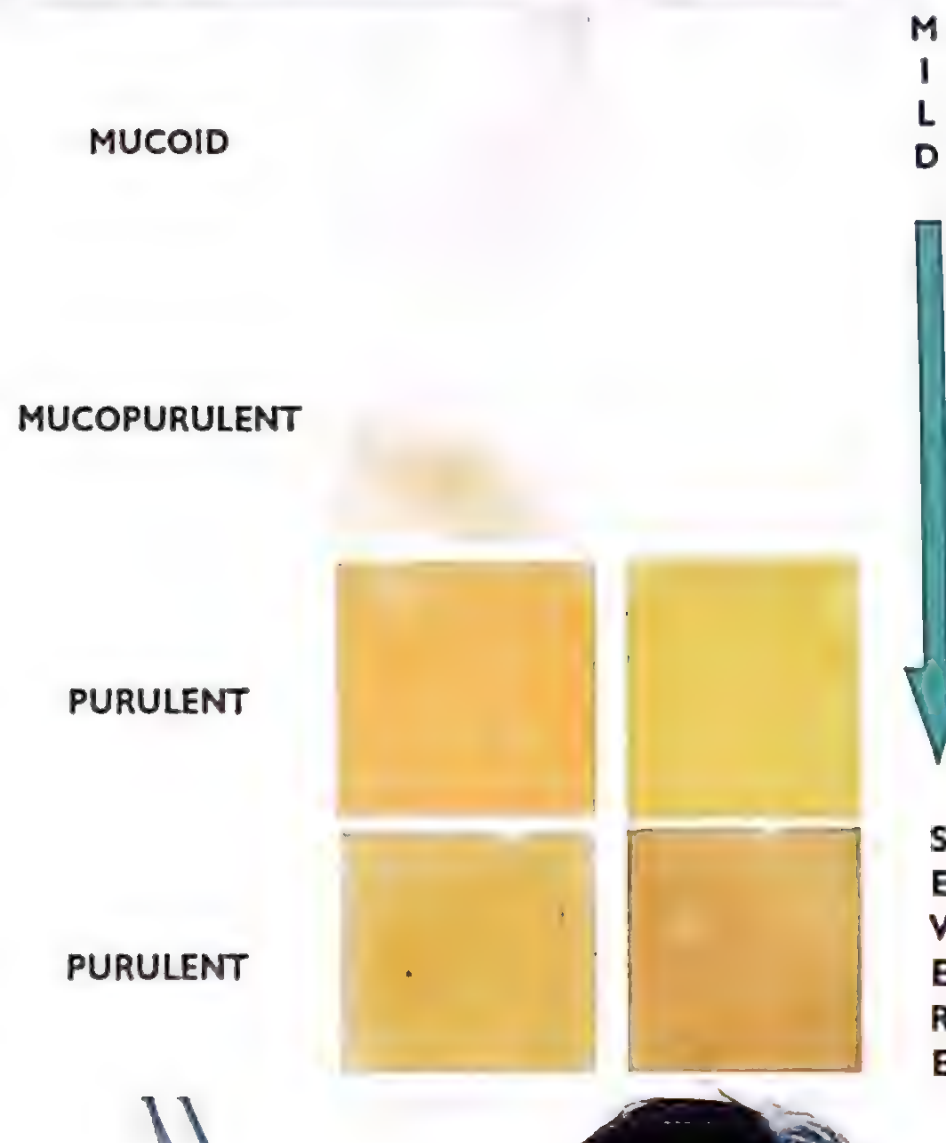
**Three-layer sputum**

Two-layer sputum, consisting of pus and serous fluid, is characteristic of a lung abscess.

Three-layer, consisting of pus, serous fluid and a foamy layer with an admixture of mucus - for bronchiectasis, gangrene, purulent bronchitis.

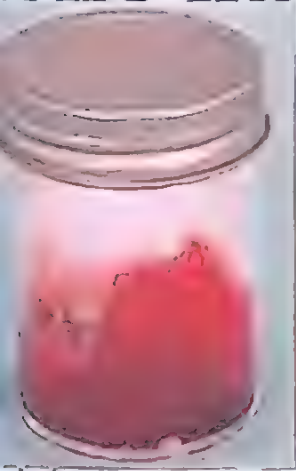
The reason for the separation is in the different relative density of the components of sputum.

# The nature of sputum



- Mucous sputum - colorless or slightly whitish, viscous, contains few cells. Mucous sputum is secreted in chronic inflammation of the upper respiratory tract, in smokers, in asthma, whooping cough and acute bronchitis.
- Serous sputum - colorless, liquid, frothy, translucent, observed in acute pulmonary edema. A characteristic feature of serous sputum is a high protein content. Such sputum is characteristic of pulmonary edema, pulmonary tuberculosis.
- Mucopurulent sputum yellow or greenish, viscous; formed in chronic bronchitis, tracheitis, bronchopneumonia
- Purulent sputum is homogeneous, semi-liquid, greenish-yellow in color. Purulent sputum is excreted in large quantities. Such sputum is characteristic of the fibrous-cavernous form of tuberculosis. A large amount of purulent, greenish, putrid-smelling sputum is released during a lung abscess

# The nature of sputum



**Bloody sputum can be either pure blood or mixed.**

**Purely bloody sputum is observed in pulmonary tuberculosis, but it can be actinomycosis, gangrene, syphilis, and lung cancer.**

**Mixed bloody sputum can be:**

- **Muco-bloody sputum with pulmonary infarction with damage to the upper respiratory tract or nasopharynx.**
- **Muco-purulent-bloody sputum with streaks of blood is excreted in tuberculosis, severe congestive catarrh of the respiratory tract, neoplasms, actinomycosis.**
- **Serous-bloody sputum with pulmonary edema,**
- **Purulent-bloody sputum, semi-liquid with gangrene and lung abscess.**

**If the blood is released slowly, its hemoglobin turns into hemosiderin and gives the sputum a rusty color, characteristic of croupous pneumonia.**



## **Smell**

**The smell of sputum is absent. If the sputum has a fetid or putrid odor, then this indicates tissue breakdown, which can be with lung gangrene or decaying cancer. The smell can be from the decomposition of sputum proteins during its retention in the cavities (abscess, bronchiectasis, tuberculosis).**

**Medium reaction pH**

**pH of sputum is alkaline.**

**Acid can be in the presence of impurities of gastric juice (with hematemesis).**

***Sputum elements that are found in the native preparation can be divided into three main groups:***

***1. Cellular***

***2. Fibrous***

***3. Crystalline***





# Cellular elements of sputum

Leukocytes-  
neutrophils  
(lung abscess,  
bronchiectasis,  
tuberculosis);

Eosinophils  
(bronchial asthma,  
helminthiases,  
echinococcosis of the  
lung);

Mast cells or tissue  
basophils (allergic  
alveolitis)

Lymphocytes  
(allergic alveolitis,  
tuberculosis,  
ascariasis)

Erythrocytes  
(pulmonary bleeding,  
stagnation in the ICC,  
neoplasms,  
tuberculosis);

Alveolar macrophages  
(pneumonia, bronchitis,  
pulmonary infarction),  
siderophages  
(hemosiderin),  
foamophages;

Cylindrical ciliated  
epithelium, atypical  
cells.

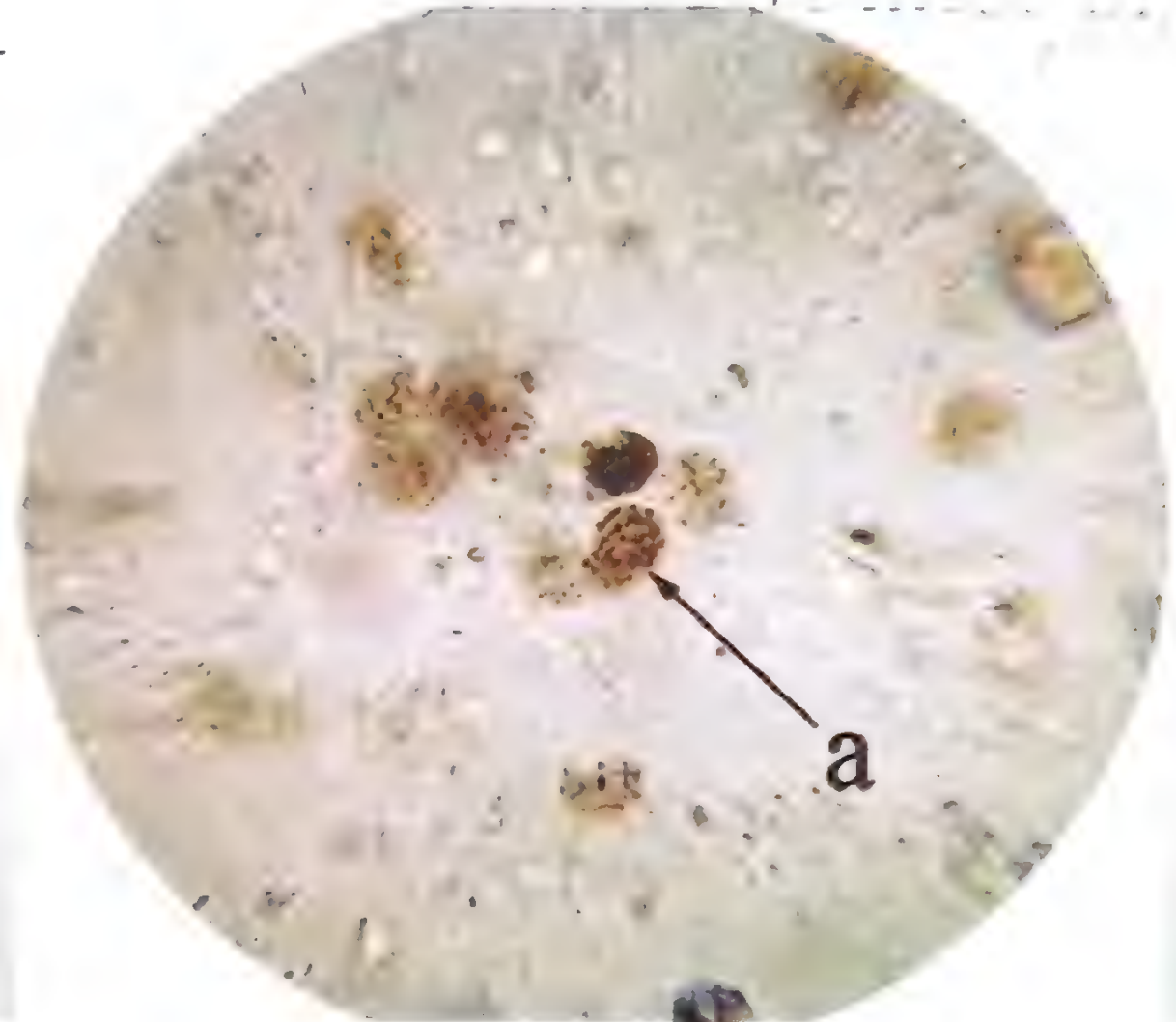
**Mucous sputum, gray in color with an admixture of blood**

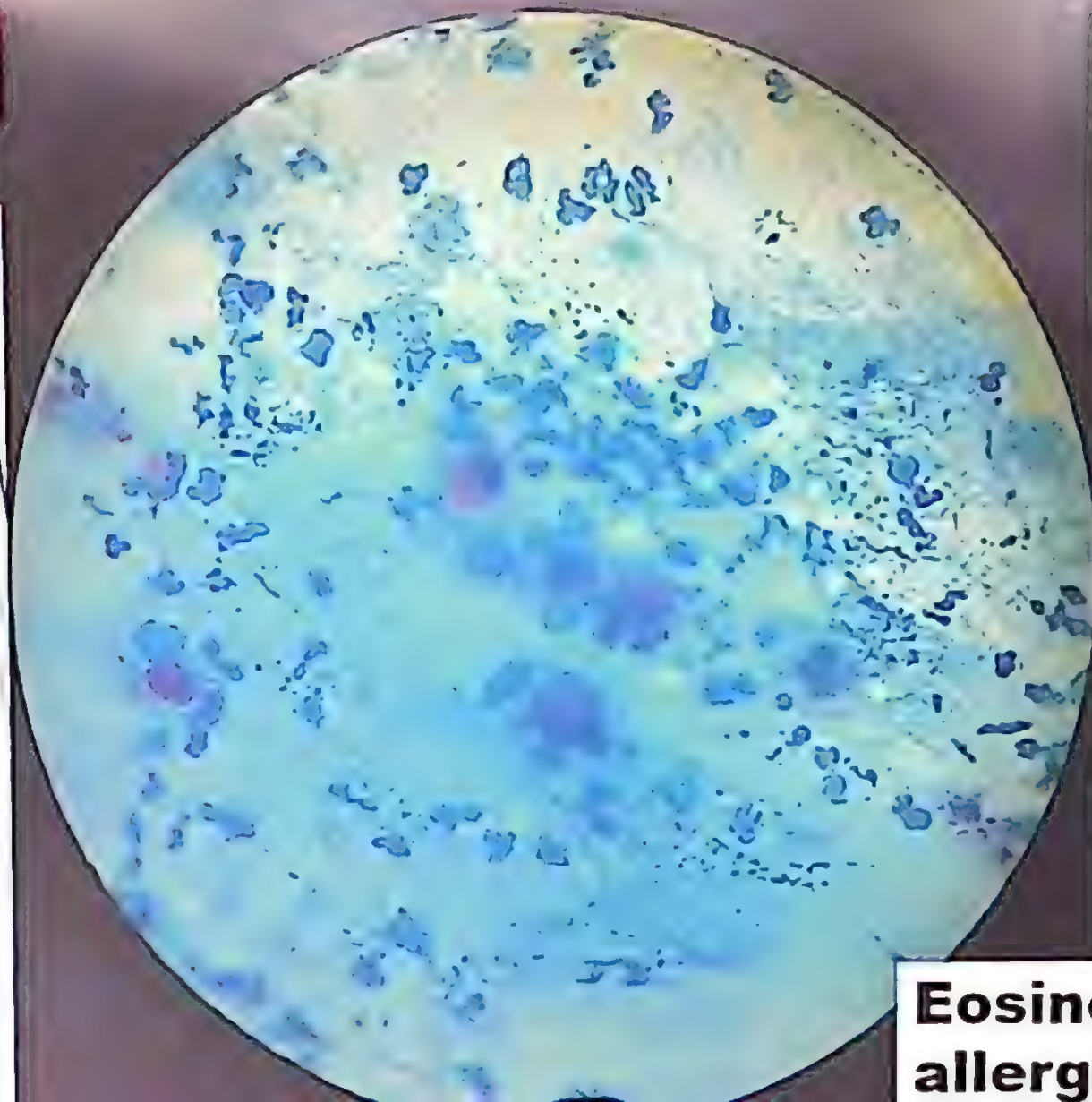
**a) macrophages**

**Alveolar macrophages in the lungs perform the following functions:**

- **phagocytic,**
- **secretory,**
- **representing an antigen**

**In the mucus, they are located in small groups or large clusters. In liquid, serous sputum, they have a round shape, in viscous - they are drawn out.**





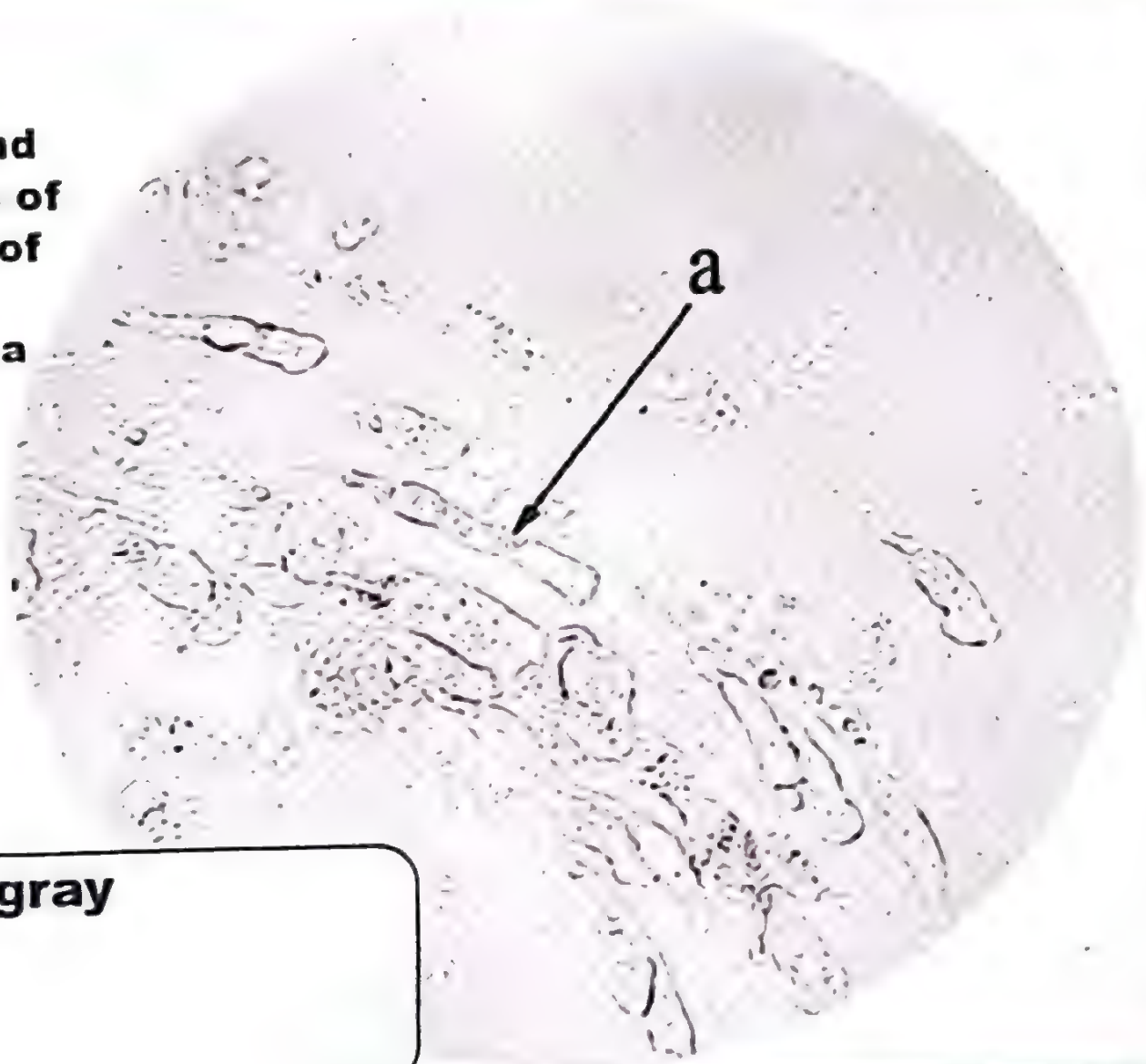
**The cytoplasm of eosinophils contains granules with a large amount of alkaline protein and peroxides that have bactericidal activity.**

**Eosinophils have weak phagocytic activity and cause extracellular cytolysis,**

**Eosinophils appear in sputum in allergic diseases**

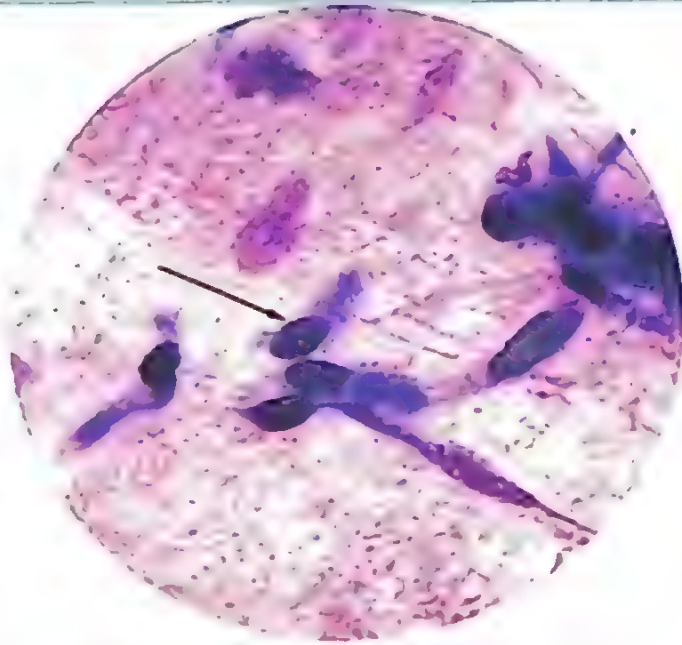


**A large number of cylindrical ciliated epithelium cells are found in sputum in acute catarrhs of the upper respiratory tract of various etiologies, chronic bronchitis, bronchial asthma and lung neoplasms, pneumosclerosis.**

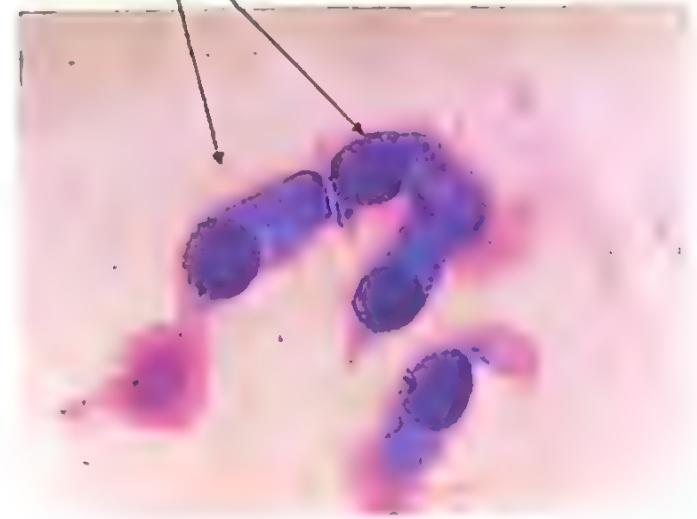


**Sputum purulent-mucous, gray  
a) cylindrical epithelium.**

**Sputum is purulent-mucous, gray in color.**



**cylindrical epithelium.**



## **Fibrous structures**

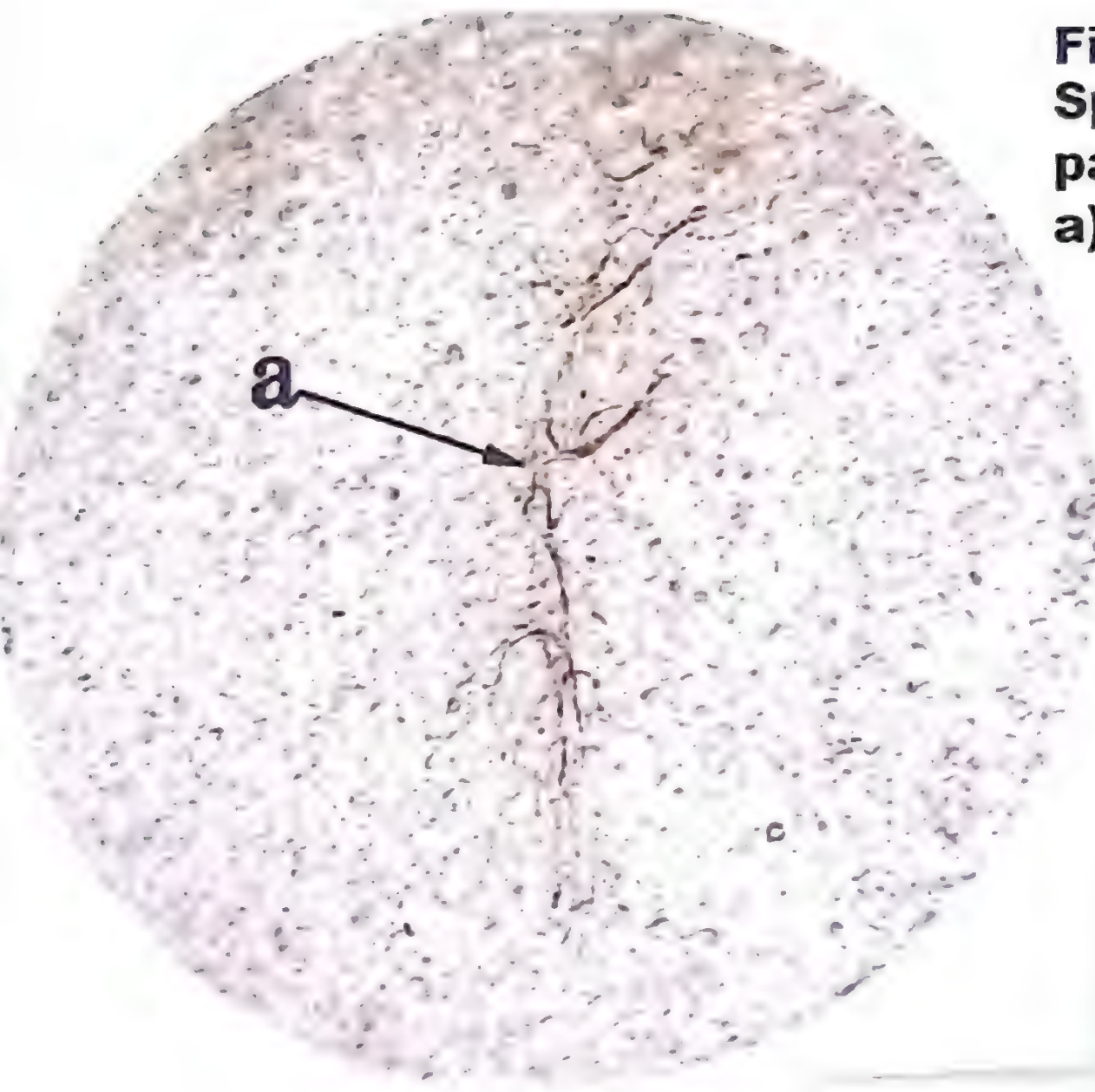
- Elastic fibers (elements of connective tissue, destructive processes)**
- Coral fibers (cavernous tuberculosis) Calcified elastic fibers**
  - Fibrin (bronchitis, pneumonia)**
- Kurshman's spirals (formations from mucus, bronchial asthma)**



## **Fibrous formations**

**Elastic fibers are formed from connective tissue elements and are found in sputum during destructive processes in the lungs. In the native preparation, elastic fibers look like crimped, shiny, thin, delicate fibers. Usually located on the background of leukocytes and detritus. They are found in tuberculosis, abscess, neoplasms of the lungs, gangrene of the lung.**

- ✓ **With cavernous tuberculosis, as a result of the deposition of fatty acids and soaps on the fibers, they become rough and thick. Then they are called coral fibers. Rarely found.**



**Fibrous formations**  
**Sputum purulent with dense**  
**patches**  
**a) elastic fibers**

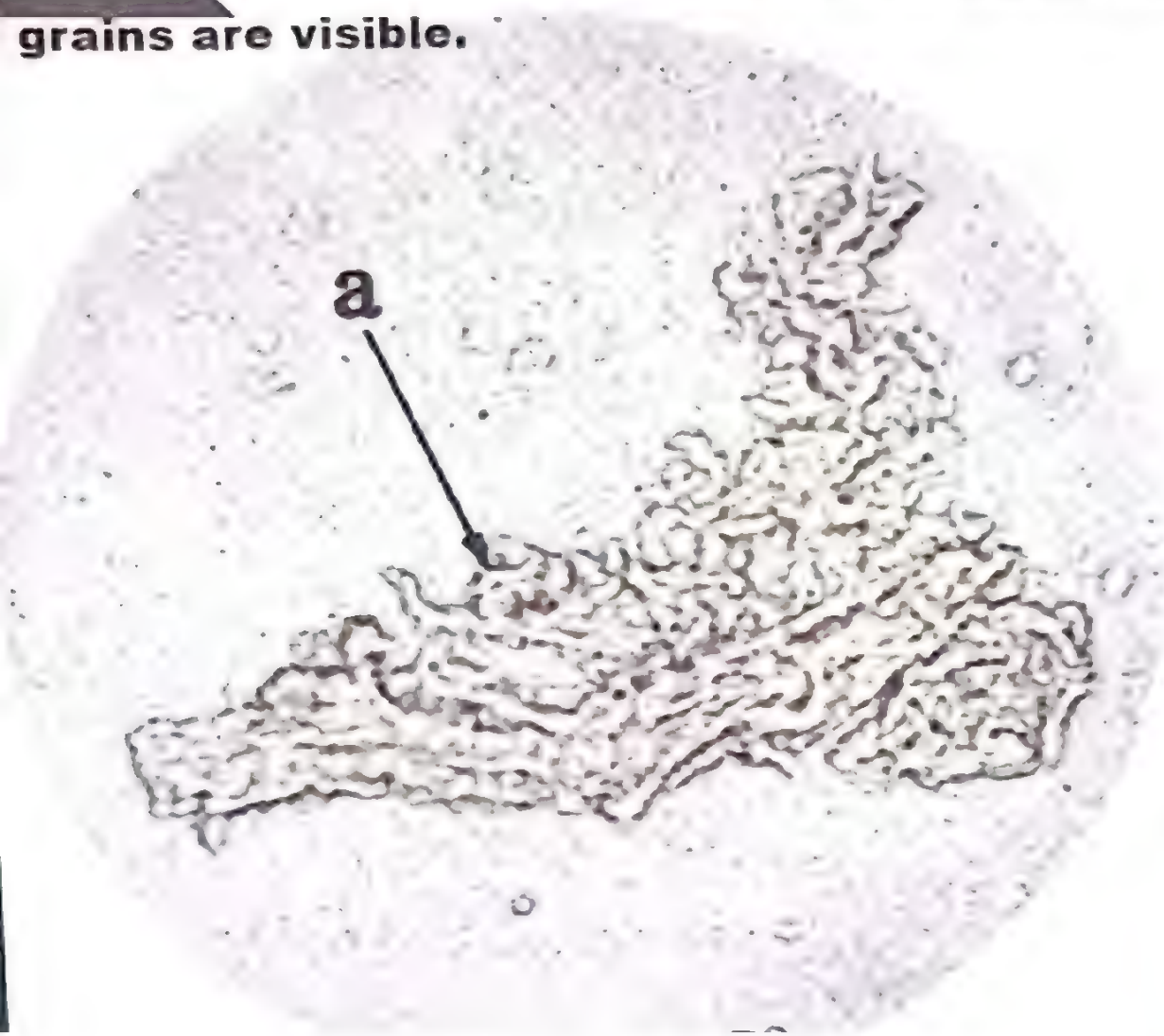
**Elastic fibers found in**  
**sputum during destructive**  
**processes in the lungs**

## Fibrous formations

**Sputum** is mucopurulent. Against the background of pus, dense areas and gray grains are visible.

### a) coral fibers

as a result of the deposition of fatty acids and soaps on the elastic fibers, they become rough, thick, have uneven contours. Found in cavernous tuberculosis, rare







✓ **Fibrous formations**  
**Kurshman's spirals** are compacted, twisted into a spiral formations of mucus. The central axial thread looks shiny. On the periphery, the mucus lies more freely and forms the so-called mantle. Their size can be different.

Spirals are formed in the presence of spasm or compression of the bronchi, containing a viscous mucous secret, coughed up with difficulty.

They are found in the sputum of patients with bronchial asthma or with lung tumors.



## **Fibrous formations**

**Sputum is purulent-mucous,  
gray-yellow in color.**

**a) Curshman's spirals**

**Kurshman spirals are  
dense mucus in the form  
of an axial cylinder,  
surrounded by mucus,  
the so-called mantle.**

## Fibrous formations

- ✓ Fibrin is a network of parallel thin fibers. It is observed in inflammatory processes (fibrinous bronchitis, tuberculosis, actinomycosis, croupous pneumonia).
- ✓ Mucus is found in the form of fibrous formations, light strands, with fuzzy, blurry, irregular outlines..



## **Crystalline formations**

**-Charcot Leiden Crystals**

**-Hematoidin crystals**

**-Cholesterol crystals**

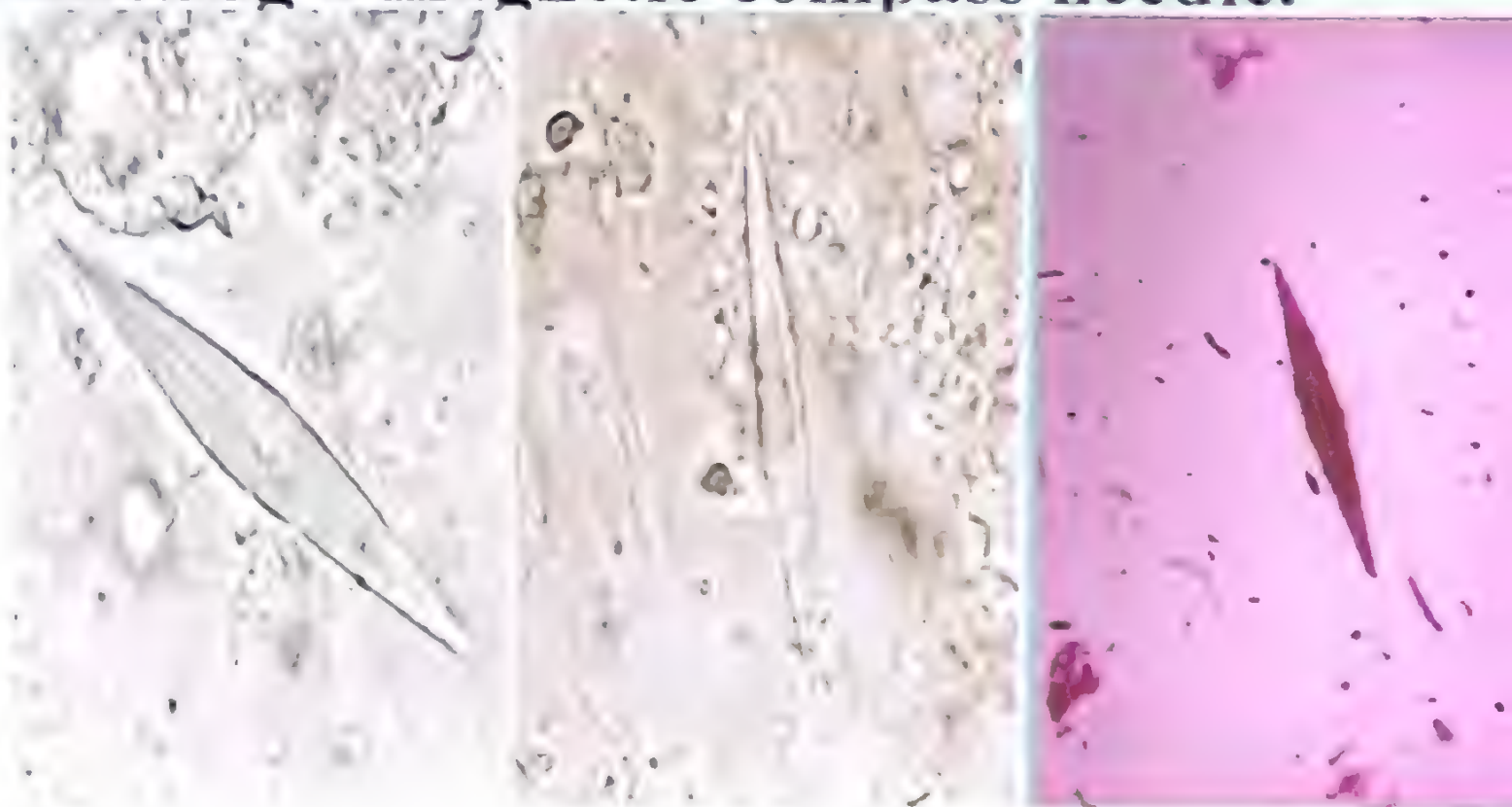
**-fatty acid crystal**

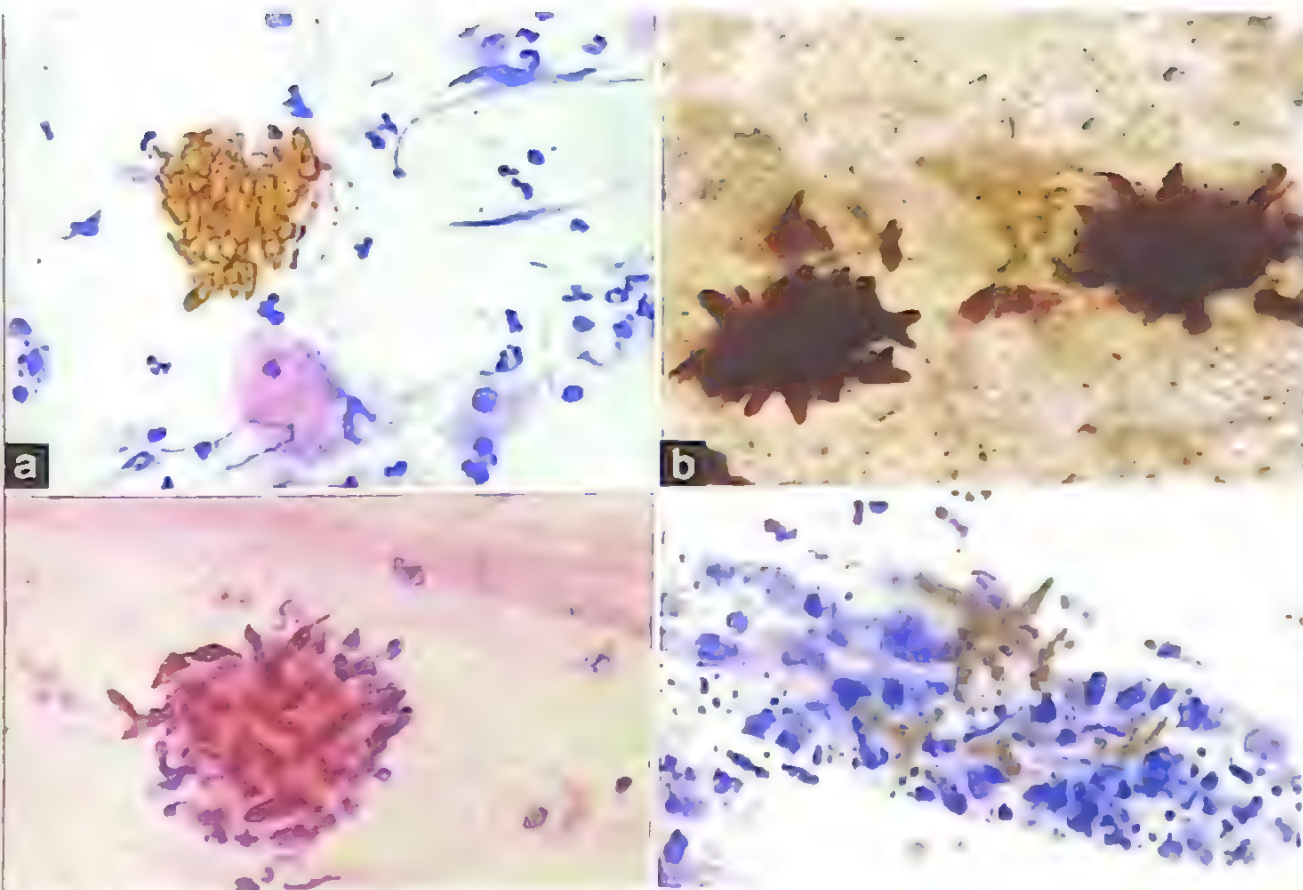
**-smyelin**

**1. Charcot-Leiden crystals** look like elongated, shiny colorless rhombuses (octahedrons) with pointed ends of various sizes, resembling a magnetic compass needle.

Formed from  
decaying eosinophils  
Fresh sputum often  
does not contain  
crystals Charcot  
Leiden, they appear  
within 24 hours.

They are found in  
bronchial asthma,  
with damage to the  
lungs by helminths





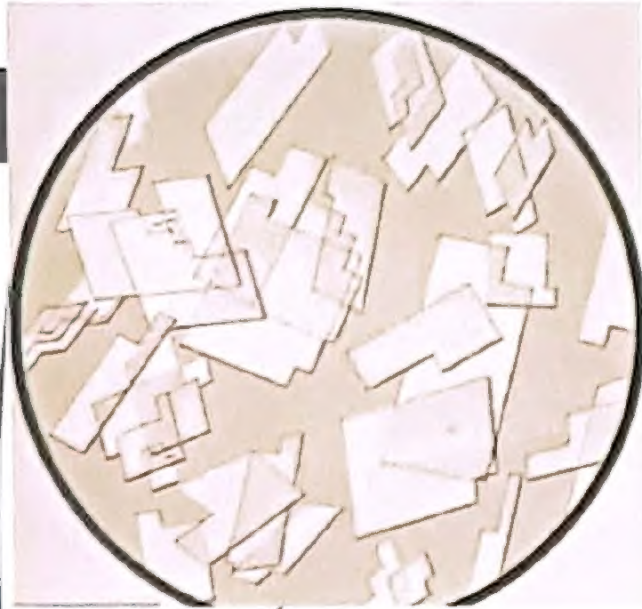
**Hematoidin crystals are characteristic of abscess and gangrene of the lung**

## **Crystalline formations**

**2. Crystals of hematoidin** are rhombus-shaped, sometimes golden-yellow needles. They are a product of the breakdown of hemoglobin, are formed in the depths of hematomas and extensive hemorrhages, in necrotic tissue. In sputum preparations, they are located against the background of detritus, elastic fibers, in necrotic tissue patches.



## Crystalline formations



3. Cholesterol crystals look like colorless quadrangular tablets with a broken corner. Cholesterol crystals are formed during the breakdown of fat cells, with sputum retention in the cavities. They are found in tuberculosis, neoplasms, lung abscess, lung gangrene, echinococcosis.

4. Fatty acid crystals are long thin needles and drops. Fatty acid crystals can occur during stagnation of sputum in cavities (tuberculosis, lung abscess, bronchiectasis).

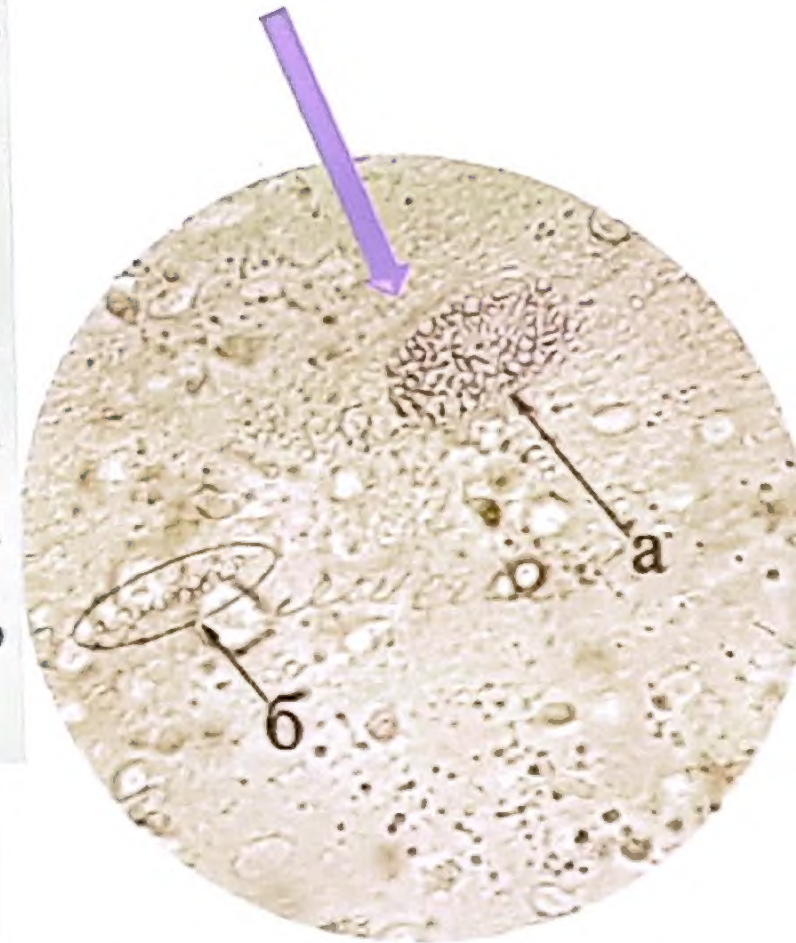




**Mucous sputum, streaked with pus, yellowish-gray.(native preparation) a) myelin formation b) myelin**

**5. Myelin** is the end product of autolysis of cells and mucus, is a necrotic detritus consisting of phospholipids.

Myelin formations are found in mucous sputum, lie freely or are the background for alveolar macrophages, which phagocytize them, turning into white, colorless cells.







## **Combined inclusion**

**Dietrich plugs** are detritus with bacteria, accumulations of needle-like crystals of fatty acids and drops of neutral fat. Dietrich's plugs are found in purulent sputum with lung abscess and bronchiectasis of the lungs.

**Koch lenses** (rice bodies) is gray-yellow lumps composed of elastic fibers, fatty acid crystals, often *Mycobacterium tuberculosis*; found in cavernous pulmonary tuberculosis.





## Other inclusions

Echinococcus blisters are rare in sputum. They are found in the form of fragments of the chitinous membrane (gray-white films) and echinococcus hooks.

Lung fluke (Paragonimus Westermani). Microscopic examination of sputum preparations reveals eggs of the lung fluke. The eggs are large and oval.

Roundworm larva (Ascaris Lumbricoides). With sputum microscopy, against the background of mucus with erythrocytes, eosinophils and Charcot-Leyden crystals, ascaris larvae can be detected.

Protozoa, such as Trichomonas, may also be found.